

WHAT IS CLAIMED IS:

1. An edge deviation calculation method in which a desired pattern is compared with a finish pattern to be formed on a wafer, which is predicted from a design pattern, based on a calculation of a light beam intensity, and a deviation quantity of the finish pattern from the desired pattern at each of edges of the finish pattern and the desired pattern is calculated, the calculation method comprising:
  - 10        setting a reference light beam intensity for setting the desired pattern on a wafer;
  - setting an evaluation point for comparison of the finish pattern with the desired pattern;
  - calculating a light beam intensity at the evaluation point;
  - 15        calculating a differentiation value of the light beam intensity at the evaluation point;
  - calculating an intersection of the differentiation value with the reference light beam intensity; and
  - 20        calculating a difference between the intersection and the evaluation point,
  - wherein the difference is defined as an edge deviation quantity of the finish pattern from the desired pattern.
- 25        2. An edge deviation calculation method in which a desired pattern is compared with a finish pattern to be formed on a wafer, which is predicted from a design

pattern, based on a calculation of a light beam intensity, and a deviation quantity of the finish pattern from the desired pattern at each of edges of the finish pattern and the desired pattern is  
5 calculated, the calculation method comprising:  
    setting a reference light beam intensity for setting the desired pattern on a wafer;  
    setting an evaluation point for comparison of the finish pattern with the desired pattern;  
10      calculating a light beam intensity at the evaluation point;  
    calculating a differentiation value of the light beam intensity at the evaluation point; and  
    dividing a difference between the light beam  
15 intensity at the evaluation point and the reference light beam intensity by the differentiation value,  
    wherein a result of the division is defined as an edge deviation quantity of the finish pattern from the desired pattern.

20.      3. The edge deviation calculation method according to claim 1, wherein the design pattern is a design pattern which specifies a complex transmission rate distribution, and the calculating of the light beam intensity at the evaluation point comprises:  
25      calculating Foulrier transform of the complex transmission rate distribution of the design pattern;  
    calculating a mutual transmission coefficient;

calculating a product of the mutual transmission coefficient with the complex transmission rate distribution and a value obtained as a result of the Foulrier transform of the complex transmission rate distribution; and

calculating reverse Foulrier transform of the product.

4. The edge deviation calculation method according to claim 2, wherein the design pattern is a design pattern which specifies a complex transmission rate distribution, and the calculating of the light beam intensity at the evaluation point comprises:

calculating Foulrier transform of the complex transmission rate distribution of the design pattern;

calculating a mutual transmission coefficient;

calculating a product of the mutual transmission coefficient with the complex transmission rate distribution and a value obtained as a result of the Foulrier transform of the complex transmission rate distribution; and

calculating reverse Foulrier transform of the product.

5. The edge deviation calculation method according to claim 1, wherein the calculating of the light beam intensity at the evaluation point is obtained by a polynomial of n-story (n is a natural number) differentiation of the light beam intensity at

the evaluation point.

6. The edge deviation calculation method according to claim 2, wherein the calculating of the light beam intensity at the evaluation point is  
5 obtained by a polynomial of n-story (n is a natural number) differentiation of the light beam intensity at the evaluation point.

7. The edge deviation calculation method according to claim 5, wherein, when an n-story  
10 differentiation of a light beam intensity in the vicinity of a position coordinate  $x = a$  of the evaluation point is defined as  $f(x)^{(n)}$  ( $n = 1, 2, \dots$ ), and a coefficient is defined as  $C_m$  ( $m = 0, 1, 2, \dots$ ), a polynomial of the n-story differentiation is provided  
15 as the following polynomial:

$$f(x) = C_0 f(x=a) + C_1 f^{(1)}(x=a)(x-a) + \dots + C_{m-1} f^{(n-1)}(x=a)(x-a)^{n-1} + C_m f^{(n)}(x=a)(x-a)^n.$$

8. The edge deviation calculation method according to claim 6, wherein, when an n-story  
20 differentiation of a light beam intensity in the vicinity of a position coordinate  $x = a$  of the evaluation point is defined as  $f(x)^{(n)}$  ( $n = 1, 2, \dots$ ), and a coefficient is defined as  $C_m$  ( $m = 0, 1, 2, \dots$ ), a polynomial of the n-story differentiation is provided  
25 as the following polynomial:

$$f(x) = C_0 f(x=a) + C_1 f^{(1)}(x=a)(x-a) + \dots + C_{m-1} f^{(n-1)}(x=a)(x-a)^{n-1} + C_m f^{(n)}(x=a)(x-a)^n.$$

9. The edge deviation calculation method according to claim 5, wherein a polynomial of the n-story differentiation is provided as the following polynomial in which n-story differentiation of a light beam intensity in the vicinity of a position coordinate  $x = a$  of the evaluation point is obtained by Taylor expansion when  $x = a$ :

$$f(x) = f(x = a) + f^{(1)}(x = a)(X - a)/1! + f^{(2)}(x = a)/2!(X - a)^2 + \dots + f^{(n)}(x = a)/n! \cdot (X - a)^n.$$

10. The edge deviation calculation method according to claim 6, wherein a polynomial of the n-story differentiation is provided as the following polynomial in which n-story differentiation of a light beam intensity in the vicinity of a position coordinate  $x = a$  of the evaluation point is obtained by Taylor expansion when  $x = a$ :

$$f(x) = f(x = a) + f^{(1)}(x = a)(X - a)/1! + f^{(2)}(x = a)/2!(X - a)^2 + \dots + f^{(n)}(x = a)/n! \cdot (X - a)^n.$$

11. A edge deviation calculation method according claim 1, further comprising changing at least one of the reference light beam intensity and focus within each of determined ranges, and comparing the mask pattern with the finish pattern.

12. A edge deviation calculation method according claim 2, further comprising changing at least one of the reference light beam intensity and focus within each of determined ranges, and comparing the mask

pattern with the finish pattern.

13. A edge deviation calculation method according to claim 1, wherein the design pattern is a corrected pattern corrected to provide the desired pattern.

5        14. A edge deviation calculation method according to claim 2, wherein the design pattern is a corrected pattern corrected to provide the desired pattern.

15        15. An edge deviation quantity verification method in which a desired pattern is compared with a finish pattern to be formed on a wafer, which is predicted from a design pattern, based on a calculation of a light beam intensity, a deviation quantity of the finish pattern from the desired pattern at each of edges of the finish pattern and the desired pattern is calculated, and it is determined whether or not the design pattern is to be corrected based on a result of the calculation of the deviation quantity, the verification method comprising:

20               setting a reference light beam intensity for setting the desired pattern on a wafer;

              setting an evaluation point for comparison of the finish pattern with the desired pattern;

              calculating a light beam intensity at the evaluation point;

25               calculating a differentiation value of the light beam intensity at the evaluation point;

              calculating an intersection of the differentiation

value with the reference light beam intensity;

calculating a difference between the intersection  
and the evaluation point, and define the calculated  
difference as an edge deviation quantity of the finish  
pattern from the desired pattern; and

verifying the edge deviation quantity,

wherein, in the case where the edge deviation  
quantity exceeds an allowable range, the design pattern  
is corrected based on the deviation quantity.

16. An edge deviation quantity verification method  
in which a desired pattern is compared with a finish  
pattern to be formed on a wafer, which is predicted  
from a design pattern, based on a calculation of  
a light beam intensity, a deviation quantity of the  
finish pattern from the desired pattern at each of  
edges of the finish pattern and the desired pattern is  
calculated, and it is determined whether or not the  
design pattern is to be corrected based on a result  
of the calculation of the deviation quantity, the  
verification method comprising:

setting a reference light beam intensity for  
setting the desired pattern on a wafer;

setting an evaluation point for comparison of the  
finish pattern with the desired pattern;

calculating a light beam intensity at the  
evaluation point;

calculating a differentiation value of the light

beam intensity at the evaluation point;

dividing a difference between the light beam intensity at the evaluation point and the reference light beam intensity by the differentiation value, and

5 defining a result of the division as an edge deviation quantity; and

verifying the edge deviation quantity,

wherein, in the case where the edge deviation quantity exceeds an allowable range, the design pattern  
10 is corrected based on the deviation quantity.

17. An edge deviation quantity verification program in which a desired pattern is compared with a finish pattern to be formed on a wafer, which is predicted from a design pattern, based on a calculation  
15 of a light beam intensity, a deviation quantity of the finish pattern from the desired pattern at each of edges of the finish pattern and the desired pattern is calculated, and it is verified whether or not the design pattern is to be corrected based on a result  
20 of the calculation of the deviation quantity, the verification program comprising:

setting a reference light beam intensity for  
setting the desired pattern on a wafer;

25 setting an evaluation point for comparison of the finish pattern with the desired pattern;

calculating a light beam intensity at the evaluation point;



calculating a differentiation value of the light beam intensity at the evaluation point;

calculating an intersection of the differentiation value with the reference light beam intensity;

5           calculating a difference between the intersection and the evaluation point, and define the calculated difference as an edge deviation quantity of the finish pattern from the desired pattern; and

          verifying the edge deviation quantity,

10           wherein, in the case where the edge deviation quantity exceeds an allowable range as a result of the verification, the design pattern is corrected based on the deviation quantity.

          18. An edge deviation quantity verification  
15           program in which a desired pattern is compared with a finish pattern to be formed on a wafer, which is predicted from a design pattern, based on a calculation of a light beam intensity, a deviation quantity of the finish pattern from the desired pattern at each of  
20           edges of the finish pattern and the desired pattern is calculated, and it is verified whether or not the design pattern is to be corrected based on a result of the calculation of the deviation quantity, the verification program comprising:

25           setting a reference light beam intensity for setting the desired pattern on a wafer;

          setting an evaluation point for comparison of the

finish pattern with the desired pattern;

calculating a light beam intensity at the  
evaluation point;

calculating a differentiation value of the light  
5 beam intensity at the evaluation point;

dividing a difference between the light beam  
intensity at the evaluation point and the reference  
light beam intensity by the differentiation value, and  
defining a result of the division as an edge deviation  
10 quantity; and

verifying the edge deviation quantity,

wherein, in the case where the edge deviation  
quantity exceeds an allowable range, the design pattern  
is corrected based on the deviation quantity.

15 19. An edge position quantity verification system  
having an input/output circuit, a storage, a computer,  
a display and a controller, in which a desired pattern  
is compared with a finish pattern to be formed on a  
wafer, which is predicted from a design pattern, based  
20 on a calculation of a light beam intensity, a deviation  
quantity of the finish pattern from the desired pattern  
at each of edges of the finish pattern and the desired  
pattern is calculated, and it is verified whether or  
not the design pattern is to be corrected based on  
25 a result of the calculation of the deviation quantity,  
the verification system comprising:

setting a reference light beam intensity for

setting the desired pattern on a wafer;

    setting an evaluation point for comparison of the  
finish pattern with the desired pattern;

    calculating a light beam intensity at the  
5 evaluation point;

    calculating a differentiation value of the light  
beam intensity at the evaluation point;

    calculating an intersection of the differentiation  
value with the reference light beam intensity;

10      calculating a difference between the intersection  
and the evaluation point, and define the calculated  
difference as an edge deviation quantity of the finish  
pattern from the desired pattern; and

    verifying the edge deviation quantity,

15      wherein, in the case where the edge deviation  
quantity exceeds an allowable range as a result of the  
verification, the design pattern is corrected based on  
the deviation quantity.

20      20. An edge position quantity verification system  
having an input/output circuit, a storage, a computer,  
a display and a controller, in which a desired pattern  
is compared with a finish pattern to be formed on a  
wafer, which is predicted from a design pattern, based  
on a calculation of a light beam intensity, a deviation  
25 quantity of the finish pattern from the desired pattern  
at each of edges of the finish pattern and desired  
pattern is calculated, and it is verified whether or

not the design pattern is to be corrected based on a result of the calculation of the deviation quantity, the verification system comprising:

5           setting a reference light beam intensity for  
          setting the desired pattern on a wafer;  
          setting an evaluation point for comparison of the  
          finish pattern with the desired pattern;

          calculating a light beam intensity at the  
          evaluation point;  
10           calculating a differentiation value of the light  
          beam intensity at the evaluation point;

          dividing a difference between the light beam  
          intensity at the evaluation point and the reference  
          light beam intensity by the differentiation value, and  
15           defining a result of the division as an edge deviation  
          quantity; and

          verifying the edge deviation quantity,  
          wherein, in the case where the edge deviation  
          quantity exceeds an allowable range, the design pattern  
20           is corrected based on the deviation quantity.

21. A semiconductor device manufacturing method in  
which a desired pattern is compared with a finish  
pattern to be formed on a semiconductor wafer, which is  
predicted from a design pattern, based on a calculation  
25           of a light beam intensity, a deviation quantity of the  
          finish pattern from the desired pattern at each of  
          edges of the finish pattern and desired the pattern is

calculated, it is verified whether or not the design pattern is to be corrected based on a result of the calculation of the deviation quantity, and a semiconductor device is manufactured by using a mask having the design pattern corrected based on the verification, the manufacturing method comprising:

setting a reference light beam intensity for setting the desired pattern on a wafer;

setting an evaluation point for comparison of the finish pattern with the desired pattern;

calculating a light beam intensity at the evaluation point;

calculating a differentiation value of the light beam intensity at the evaluation point;

calculating an intersection of the differentiation value with the reference light beam intensity;

calculating a difference between the intersection and the evaluation point, and define the calculated difference as an edge deviation quantity of the finish pattern from the desired pattern;

verifying the edge deviation quantity;

correct the design pattern based on the deviation quantity, in the case where the edge deviation quantity exceeds an allowable range;

forming a mask having the design pattern corrected based on the deviation quantity; and

forming a pattern corresponding to the corrected

design pattern on a semiconductor wafer by using the mask to form a semiconductor device on the semiconductor wafer.

22. A semiconductor device manufacturing method  
5 in which a desired pattern is compared with a finish pattern to be formed on a semiconductor wafer, which is predicted from a design pattern, based on a calculation of a light beam intensity, a deviation quantity of the finish pattern from the desired pattern at each of  
10 edges of the finish pattern and the desired pattern is calculated, it is verified whether or not the design pattern is to be corrected based on a result of the calculation of the deviation quantity, and a semiconductor device is manufactured by using a mask having  
15 the design pattern corrected based on the verification, the manufacturing method comprising:

setting a reference light beam intensity for  
setting the desired pattern on a wafer;

20 setting an evaluation point for comparison of the finish pattern with the desired pattern;

calculating a light beam intensity at the  
evaluation point;

calculating a differentiation value of the light  
beam intensity at the evaluation point;

25 dividing a difference between the light beam intensity at the evaluation point and the reference light beam intensity by the differentiation value, and

defining a result of the division as an edge deviation quantity; and

verifying the edge deviation quantity,

5 correct the design pattern based on the deviation quantity, in the case where the edge deviation quantity exceeds an allowable range;

forming a mask having the design pattern corrected based on the deviation quantity; and

10 forming a pattern corresponding to the corrected design pattern on a semiconductor wafer by using the mask to form a semiconductor device on the semiconductor wafer.